CAPTAN PIXEL TELESCOPE

SYSTEM SPECIFICATIONS

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1. Mechanical

The CAPTAN Pixel Telescope Tracker is of a modular design and therefore expandable. The basic cell of the telescope is built with carbon fiber tubes and has a square prism shape with dimensions of 17.0cm x 17.0cm x 34 .0cm.

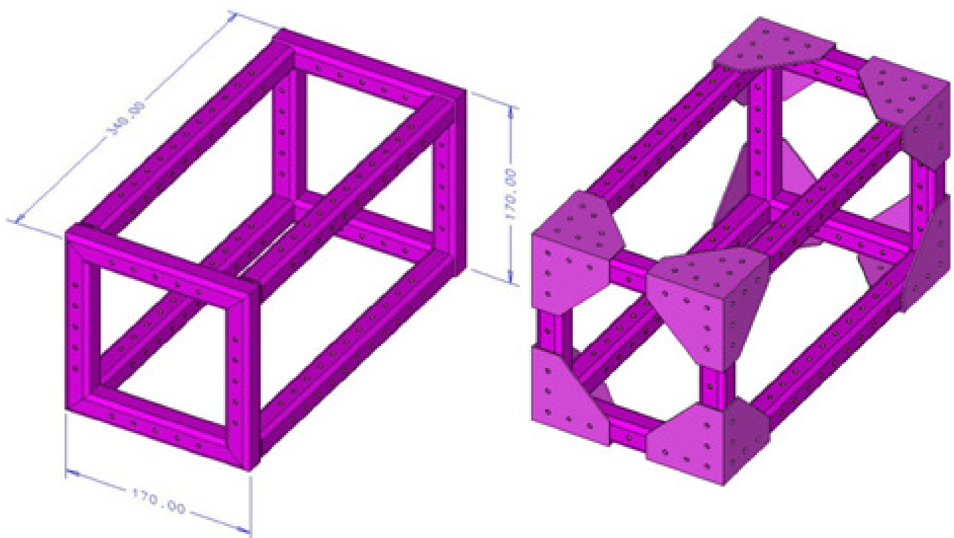


Figure 1 the basic mechanical building block of the CAPTAN Telescope (units are in millimeters).

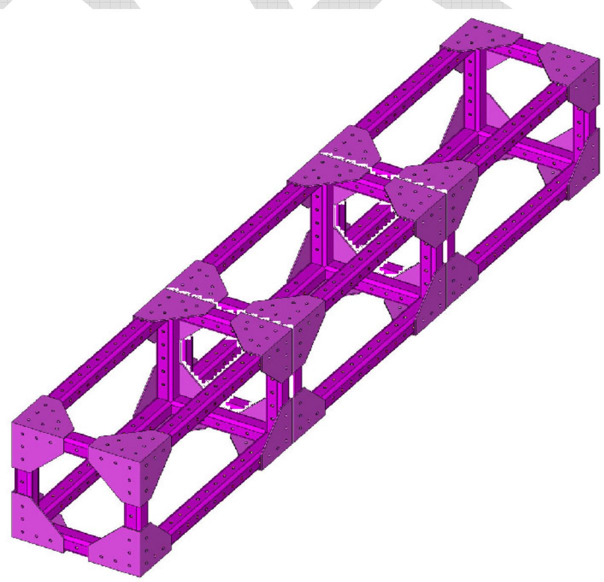


Figure 2 the current version of the telescope is composed of three basic cells.

The current version of the CAPTAN pixel Telescope uses three basic cells interconnected by its square sides as illustrated in Figure 2. The pixel tracker sits on the two extreme cells and the detector under test (DUT) on the middle one.

Different cells can be made for the DUT such as the one illustrated on Figure 3.

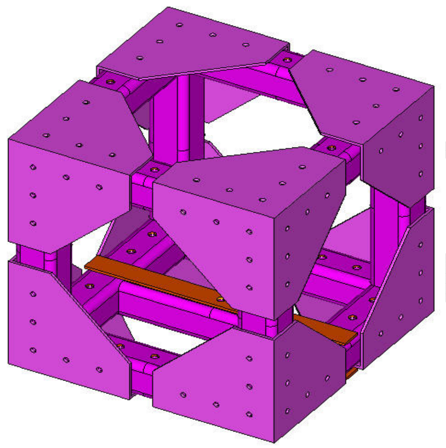


Figure 3 Optional cubic cell for the DUT.

After complete assembly, the CAPTAN pixel telescope combo is covered by a Mylar, anti-static layer.

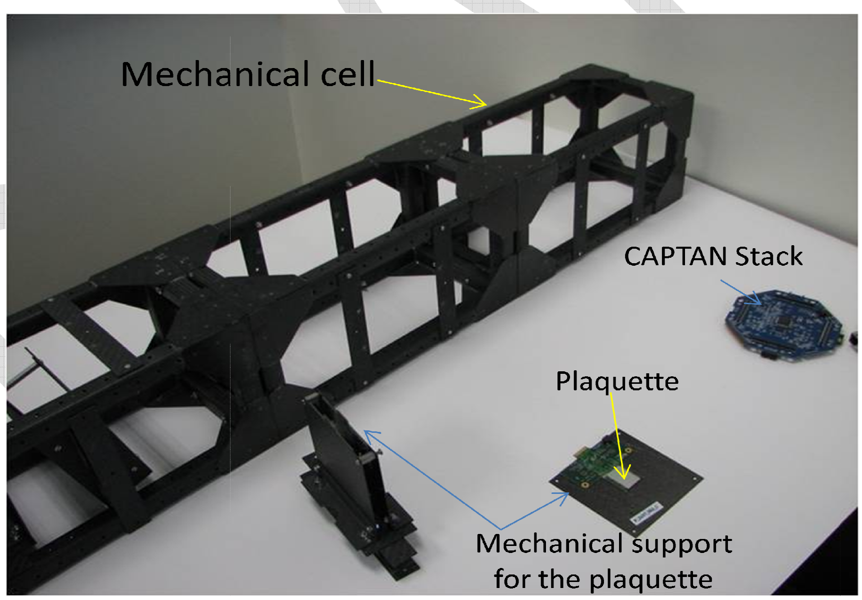


Figure 4 Parts of the telescope assembly.

2. Electronics

Each cell of the pixel telescope has a CAPTAN electronics stack attached to it. The CAPTAN electronic stack is used as the data acquisition system.

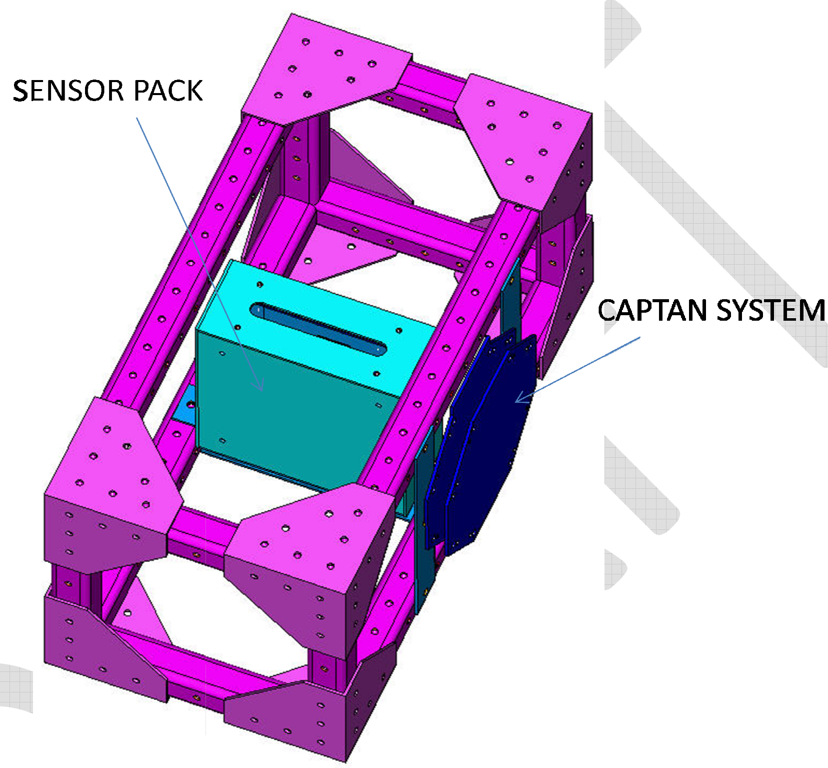


Figure 5 Mechanical cell with electronic stack.

Each CAPTAN electronic stack is Ethernet based and has its own Internet Address (IP). In the current system there are three stacks; two for the pixel telescope tracker and one for the DUT. The stacks for the tracker support four CMS pixel plaquettes each, the configuration of the plaquettes are 2x3 and 2x4. The two pixel tracker stations are called downstream and upstream, with the upstream being the station the beam first strikes. The downstream station also houses a PMT coupled with a scintillator in order to provide triggers to the system. The DUT stack supports the DUT and receives and distributes the clock from the accelerator and trigger from the scintillator.

Figure 7 illustrates the integration of the different electronic subsystems of the CAPTAN telescope and the arrangement of the 2x3 and 2x4 plaquettes.

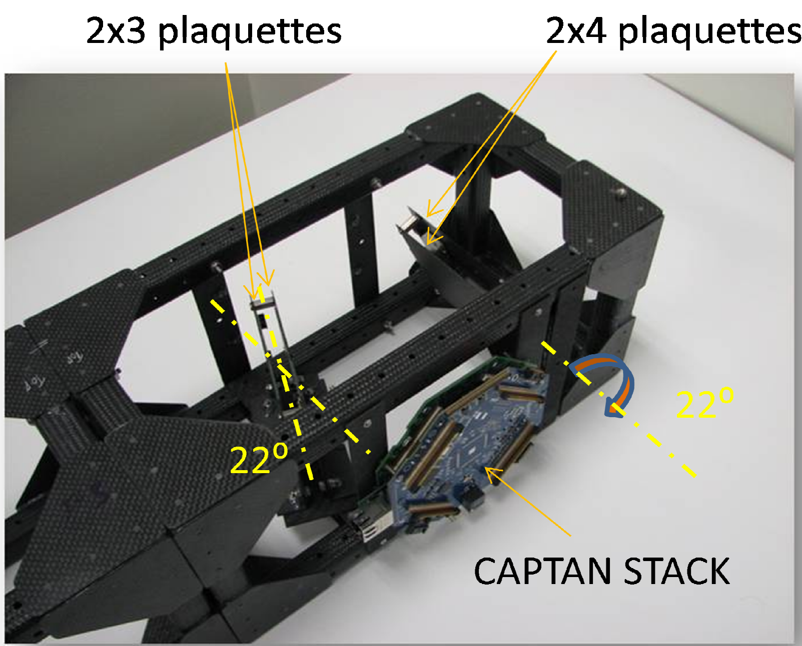


Figure 6 Pixel tracker (downstream).

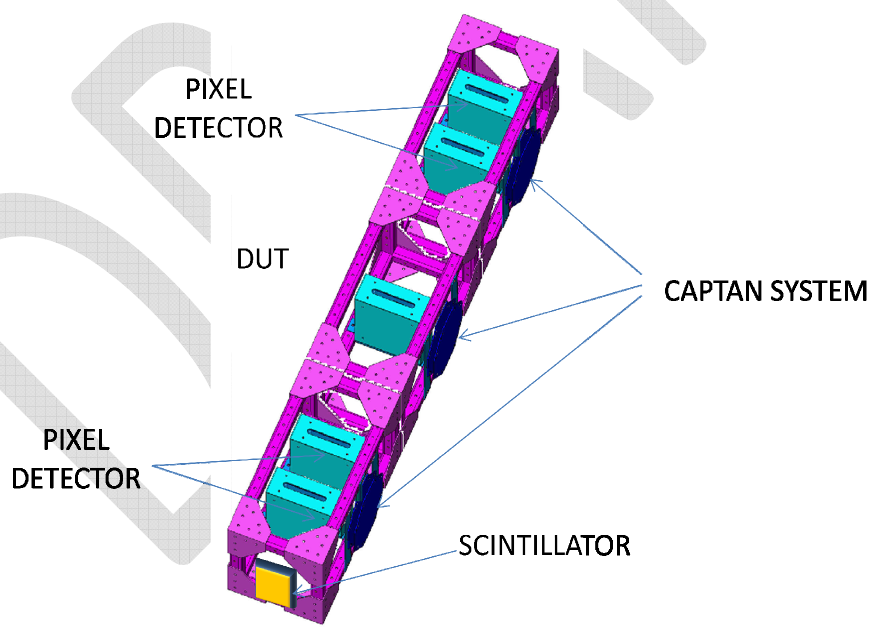


Figure 7 Location of the electronics on the telescope.

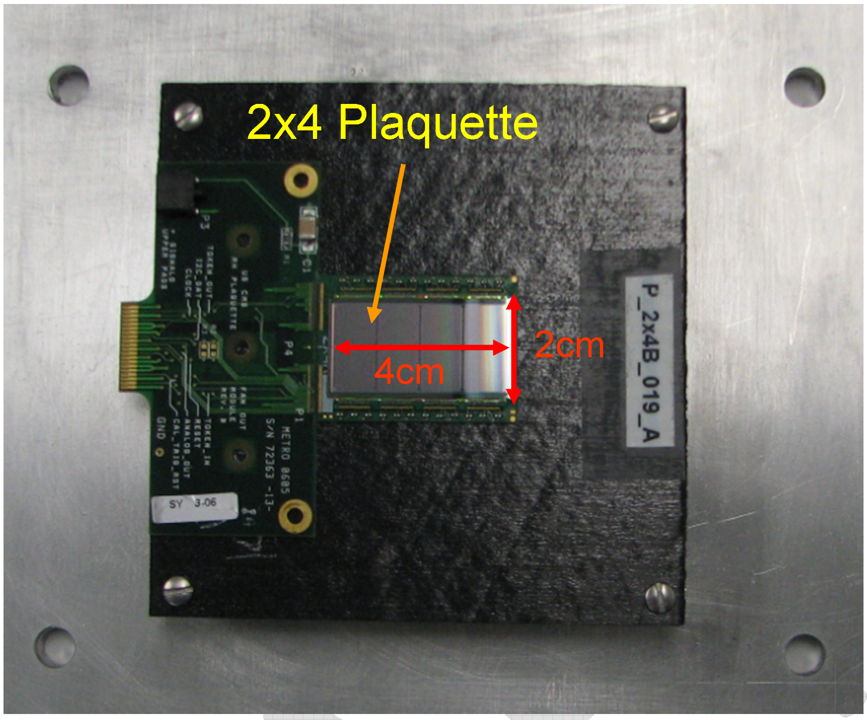


Figure 8 2x4 CMS PSI46 Plaquette

3. System Operation

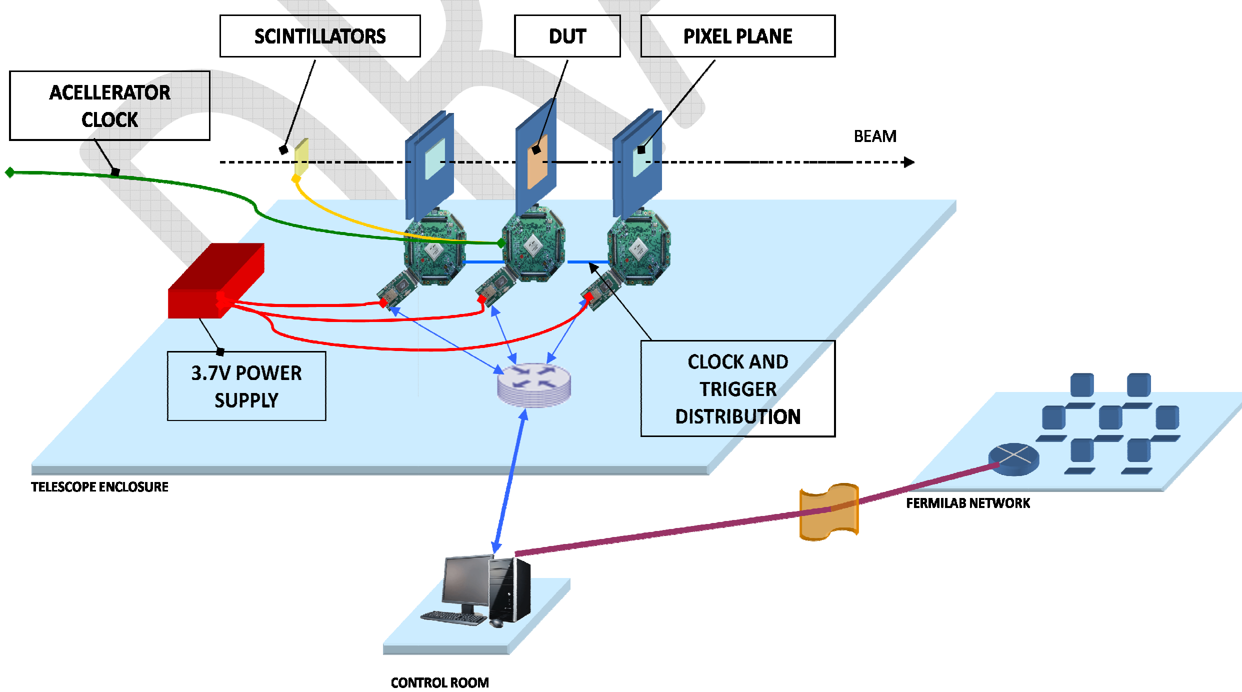


Figure 9 CAPTAN telescope system.

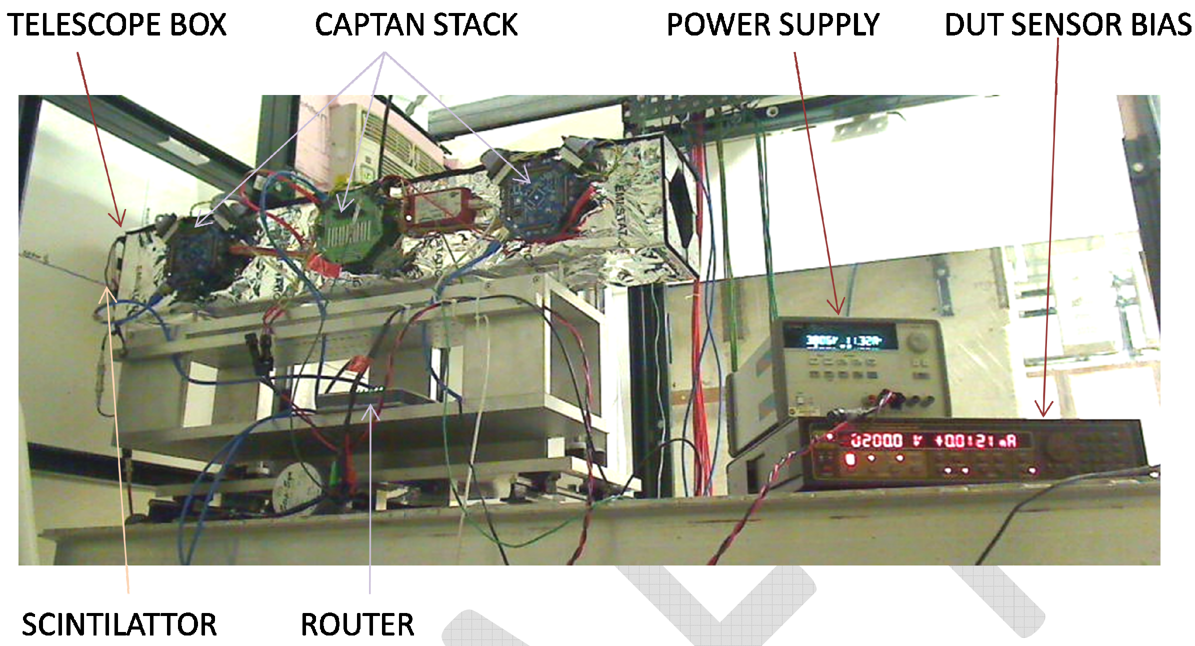


Figure 10 CAPTAN telescope at MT6.

The CAPTAN telescope operates based on the PSI46 pixel readout chip in conjunction with the CAPTAN readout system. Figure 9 and Figure 10 illustrate the system components. This telescope is a triggered one as opposed to a free running system. Currently triggers are generated by scintillator installed downstream, the signal from the scintillator runs to the DUT stack where it is distributed to the other stacks. The system can accept up to four scintillators and generate triggers based coincidence. The system can also veto triggers for an amount of time specified by the user.

There are two options for providing clock to this system: providing an external clock or using the internal programmable system clock. When using the external clock the telescope is synchronized with the accelerator and will perform better for certain applications. The internal clock is advantageous in that it can be adjustable in a range from 20MHz to 500MHz; this range depends on what kind of CAPTAN hardware is in use. For the current version (using the ADC MAX1438) the range is 20-60MHz.

All data transfer is done via Ethernet at a Gigabit per second - the same is true for register configuration of the pixel chip. The communication standard is the Ethernet protocol UDP/IP and the data flow is shown in Figure 11.

The current configuration of the telescope requires only one power supply for the tracker, one bias for the DUT and one HV bias for the scintillator. Everything else is generated by the CAPTAN system. The power consumption of the current system is approximately 40W where the voltage is 3.8V and the current ranges between 10 to 12 Amps. The eight bias voltages for the silicon sensors of the telescope are generated internally and set to -240V.

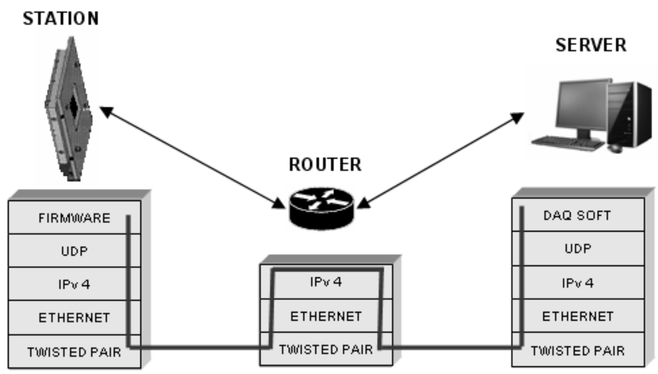


Figure 11 Data flow.

4. Software

There are four basic pieces of software designed for the CAPTAN system. They are the CAPTAN Controller (CC), the CAPTAN Global Master (GM), the CAPTAN GUI (GUI), and the CAPTAN Analysis and Display (CAD). The first three, CC, GM, and GUI are fundamental to the telescope operation and can coexist on the same computer or be distributed on different computers.

The CC provides the basic connection to the CAPTAN stack - whatever the number of stacks the number of CCs must match. In the current test beam there are three hardware stacks, therefore thee CCs must be running. Each CC connects the CAPTAN hardware to the GM. The GM is the server for the entire system – it allows for one or many GUIs to access every component in the system.

Nothing happens unless the GUI requests it. The GUI initiates all writes and reads to and from the CAPTAN. It must setup the readout chips, trigger system, clock system, run calibration procedures, and start or stop data acquisition. It also cues the CC to begin storing data to disk.

Note that are many abilities allowed for by the GUI that the standard user should never have to use. The standard user will spend almost all of their time in the User Tab.

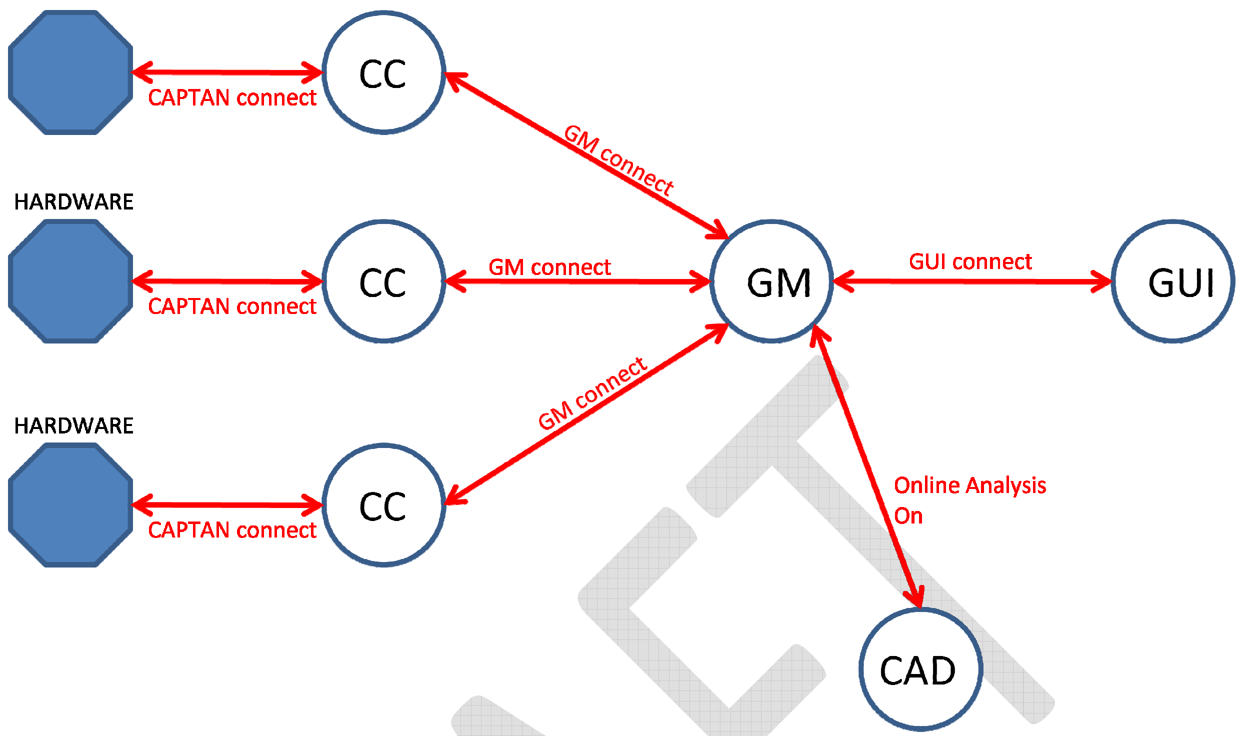


Figure 122 Distributed software topology.

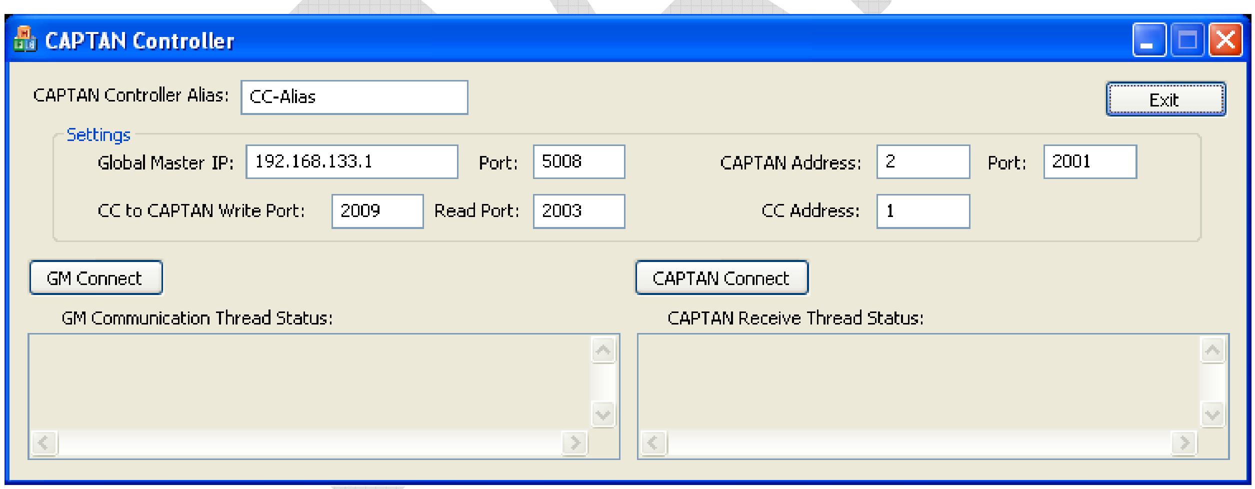


Figure 13 The CAPTAN Controller software.

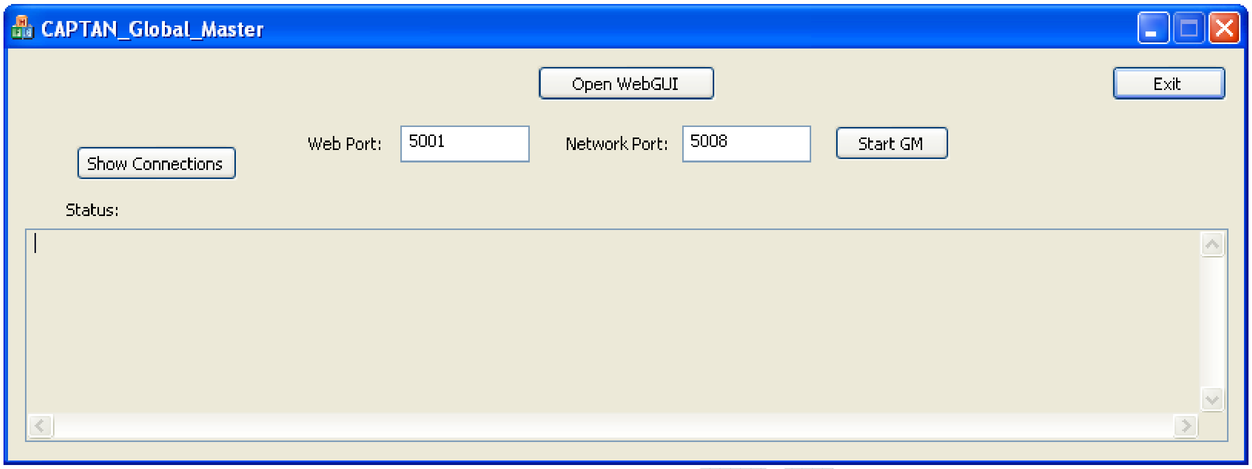


Figure 14 Global Master Software.

Figure 15 illustrates the User Tab; on the left of the window are the connection parameters which are not part of the tab. However, within the connection parameters area the user can verify how many CAPTAN stacks the GUI is connected to by checking the list on the left.

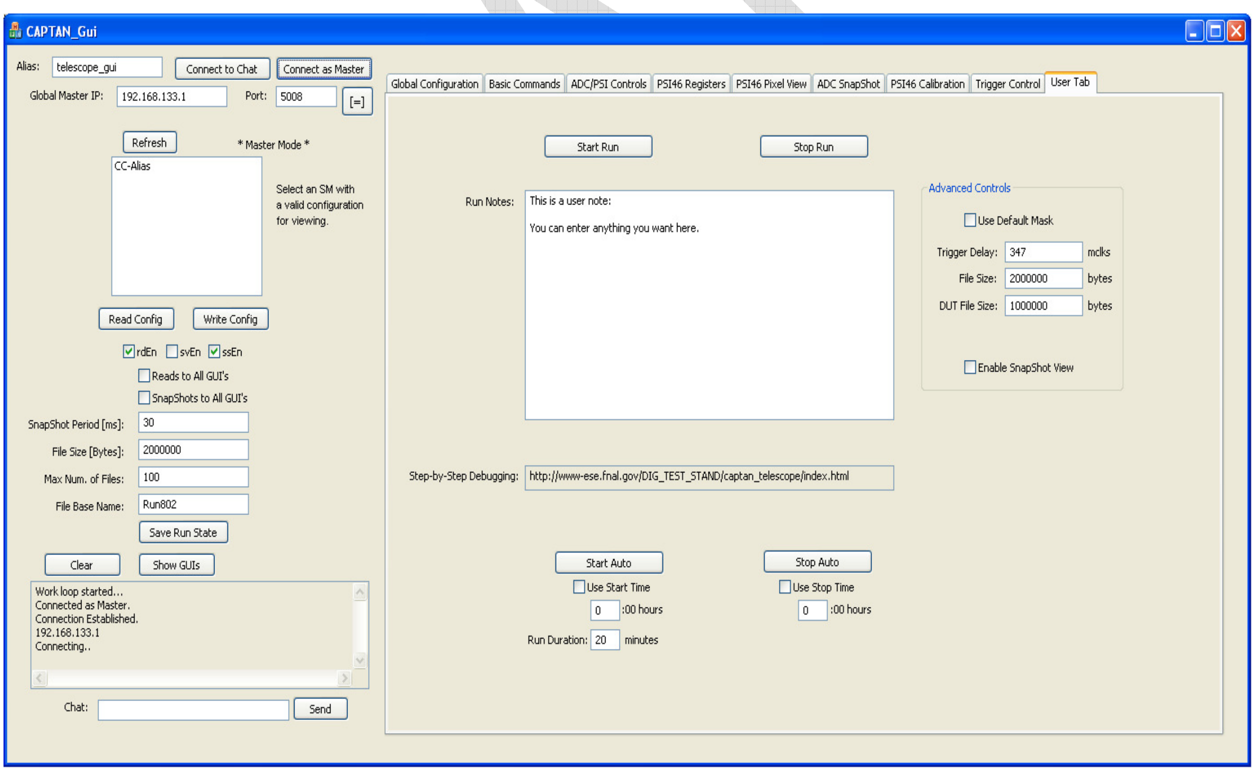


Figure 155 GUI user tab.

The final member of the software suite is the CAD which allows the user to visualize the telescope data in 3D as shown in Figure 16.

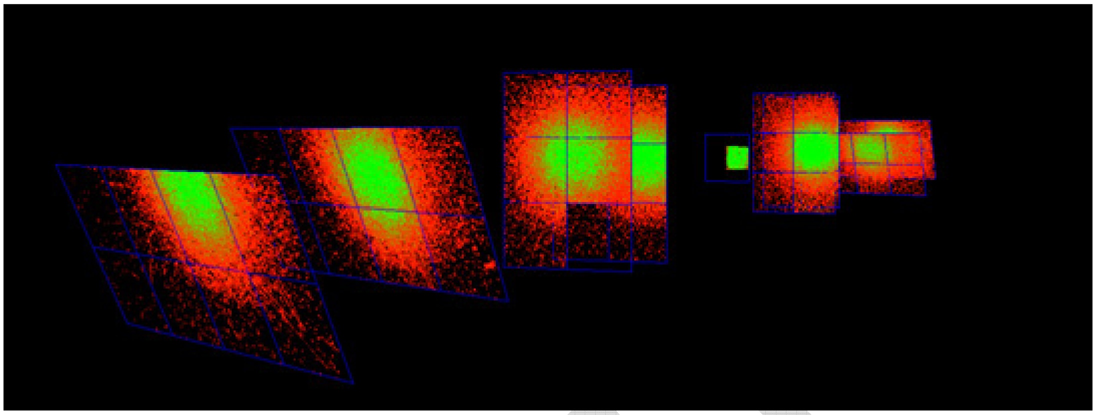
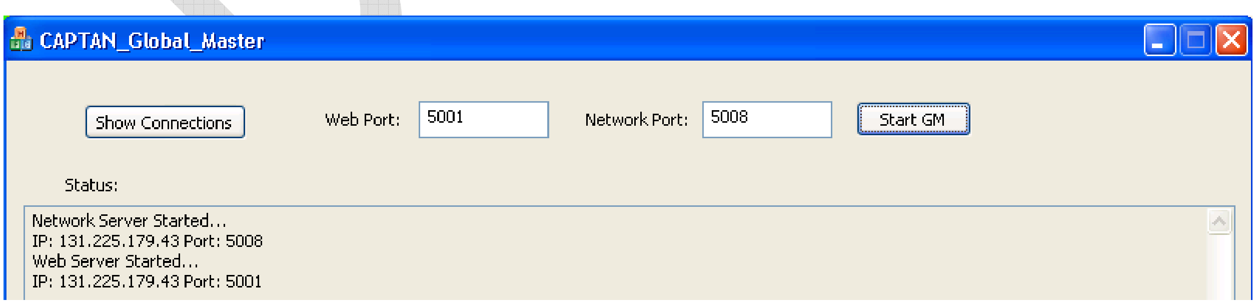


Figure 166 Visualizing the data on the analysis software.

Step-by-Step User Guide to Telescope Startup

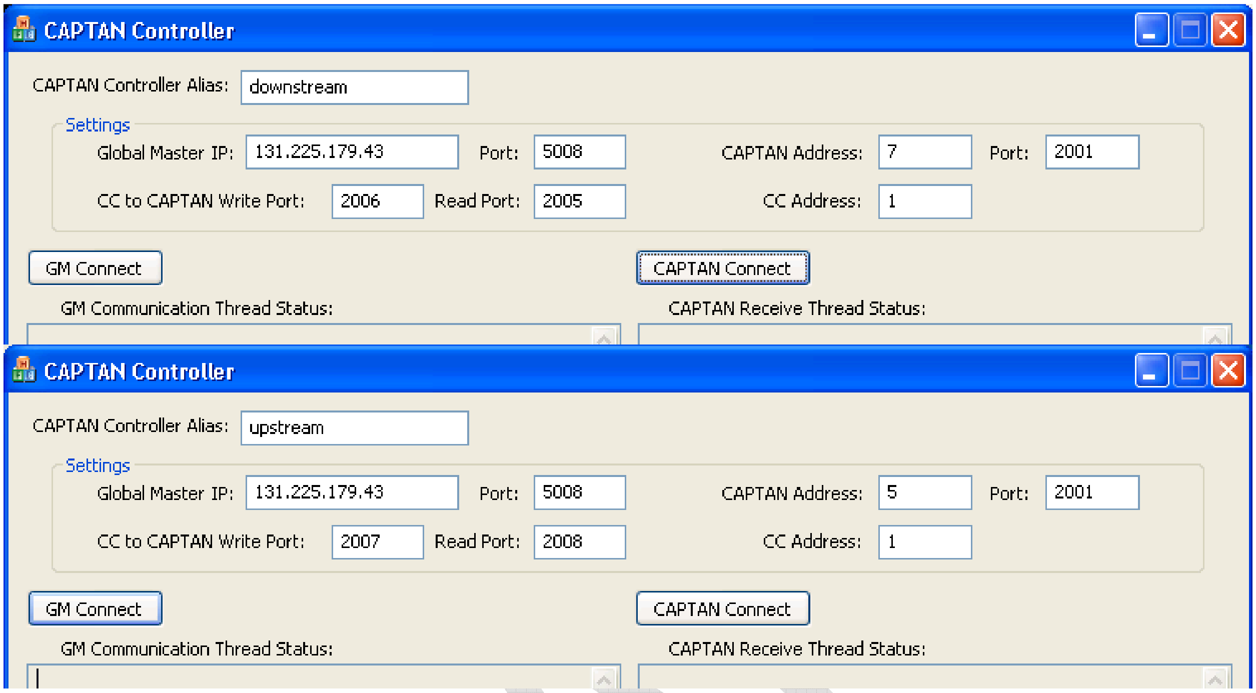
1. Every user on the PACKARD desktop machine has on their desktop the *Telescope App Launcher.* Execute it and all the applications of the CAPTAN software suite will launch.

2. Locate the *CAPTAN_Global_Master* (GM) program. Check that the *Network Port* is set to 5008, then press <Enter> or click *Start GM*. Note the IP address displayed in the status window – this IP is needed to connect the applications to the GM. Minimize the GM.

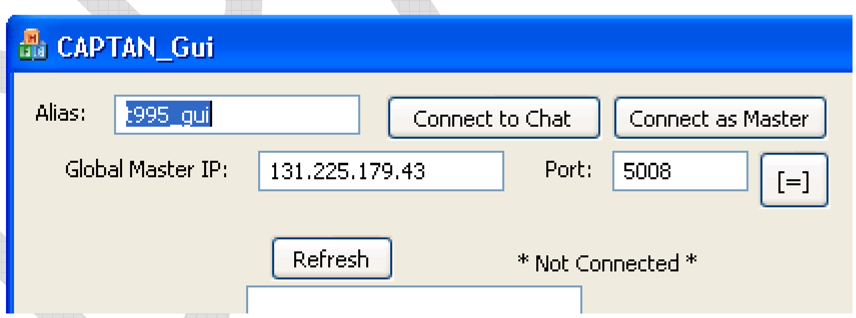


3. Locate the two *CAPTAN Controller* (CC) programs. The *CAPTAN Controller Alias* entries should be "upstream" and "downstream." Check that the *Global Master IP* matches the IP address that the GM reported in Step 2. Check that the other Settings entries match the screenshot below. Press

<Enter> or click *GM Connect* for each CC. Arrange the windows so the *CAPTAN Receive Thread Status* fields can both be viewed.



4. Locate the CAPTAN_Gui (GUI) program. The *Alias* can be anything without spaces. Check that the *Global Master IP* field and *Port* match the GM's settings. Standard users should not have to touch the other settings. Click *Connect as Master*.



5. Find the *User Tab*. Edit the *Run Notes* to reflect the current state of affairs. If a single run is desired click *Start Run*. A sequence of events that takes less than a minute should commence to setup the run. Hit *Stop Run* to end the run.

   If many runs are desired, the lower fields can be used to setup many runs one after the other. *Run Duration* is the length of the runs in minutes. Check the *Use Start Time* box to start the automatic runs sometime in the next 24. Check the *Use Stop Time* box to end the automatic runs sometime within 24 hours after the automatic runs have begun. Both checkboxes are linked to input fields that take a value 0-23 corresponding to the time of day.

E.g. If the current time is 1pm and 14 is entered as the start time, 5 Is entered as the stop time, and 20 is entered as the run duration, then automatic runs will begin one hour from now (2pm), stopping and re-starting every 20 minutes, until 5am the next day.